The Effect of Pinhole Collimator Masking: A New Consideration for Thyroid Imaging

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When pinhole thyroid scintigraphy is performed using a large field scintillation camera, what you see may not be what you think you see. Using a standard thyroid phantom and a cobalt-57 ruler-marker, we evaluated the actual field of view of a large-field camera-pinhole system. Because the design of the collimator masks the periphery of the large crystal, the actual useful field was markedly restricted to the center. This may be a potentially serious pitfall in thyroid scintigraphy since the field cut is not apparent on images. This pitfall can be avoided by always using the "zoom" feature for this pinhole imaging system.

Pinhole thyroid scintigraphy has become a very useful and widely accepted imaging tool over the past several years. This is due mostly to the superiority of the scintillation camera with pinhole collimator compared to the rectilinear scanner in resolution and convenience in obtaining multiple views. Another important factor is the availability of I-123, a suitable gamma emitter for the scintillation camera.

Pitfalls of pinhole imaging, however, have been noted; accurate sizing of the thyroid is difficult and distortion of anatomy is inevitable. We report a new pitfall of pinhole imaging caused by collimator design in a particular instrument, the Raytheon Step 1/Step 2 scintillation camera. Use of this pinhole collimator can mask the crystal and lead to a potentially serious error in interpretation of thyroid imaging studies.

Materials and Method

A standard thyroid phantom (Atomic Products Corp., Center Moriches, NY) was prepared with 10 μCi of Tc-99mO_4. A 50 cm long, flexible, sealed Co-57 ruler-marker of alternating 2 cm sections of Co-57 and nonradioactive plastic was taped in a straight line on an imaging table. The thyroid phantom was placed on top of the ruler-marker. A scintigram of this arrangement with a parallel hole collimator is shown in Fig. 1. The total field of view of the Raytheon Step 1/Step 2 camera is 42.4 cm. The camera was then fitted with a pinhole collimator with 2 mm aperture insert. The collimator was centered at a distance 5 cm above the thyroid phantom. A series of 50K count images, with and without "zoom" magnification, were obtained.

Results and Discussion

The pinhole image without zoom magnification (Fig. 2) demonstrates the thyroid phantom and the background scatter activity similar to a clinical radioiodine thyroid scan. It shows, however, only the center 13 cm of the 50-cm marker, indicating the rest of the field of view is actually not viewed by the detector. This became more evident when a 41-cm diameter Co-57 uniform flood source was inserted under the thyroid phantom (Fig. 3). The actual field of view is considerably

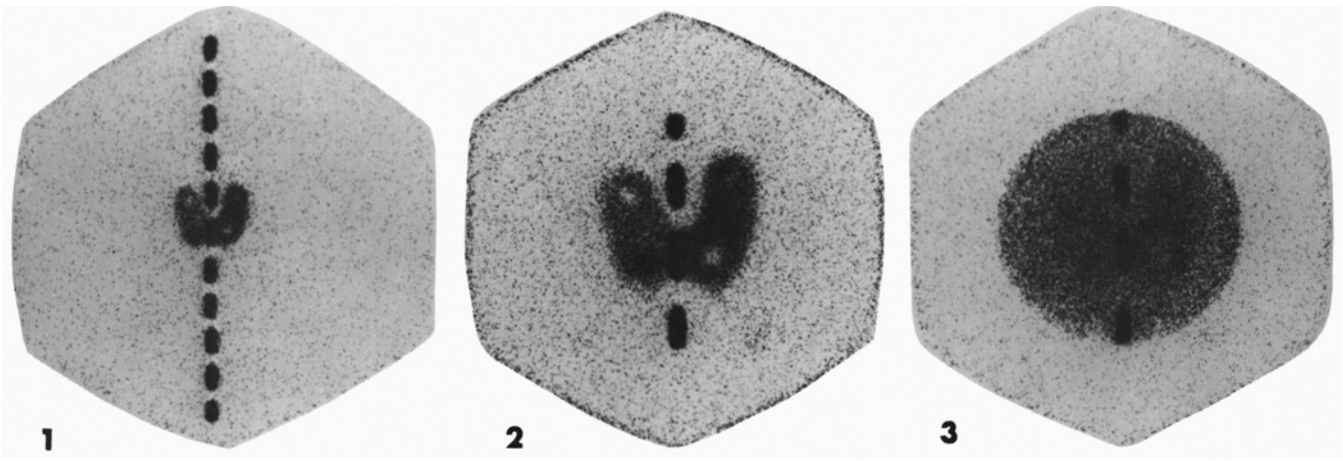

FIG. 1. Parallel hole collimator view of standard thyroid phantom and 50 cm long, Co-57 ruler-marker source. **FIG. 2.** Pinhole view of same thyroid phantom and Co-57 ruler-marker. Only the center 13 cm of ruler-marker is seen. Note much larger background area, which gives a false impression of seeing as much extrathyroidal area. **FIG. 3.** Pinhole view of same thyoid phantom and ruler-marker, plus a Co-57 flood source. The actual field of view of pinhole system is shown (center).

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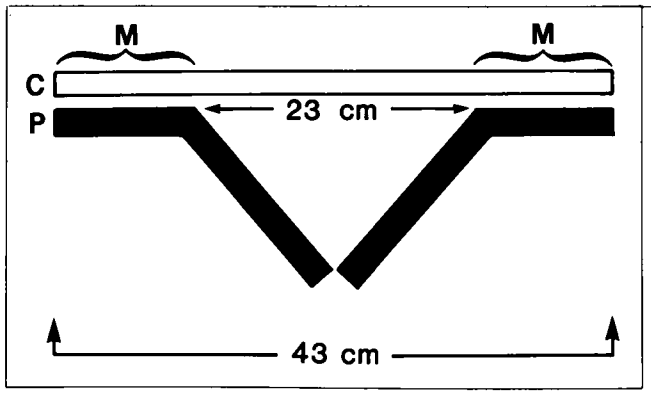

FIG. 4. Schematic diagram of pinhole collimator. Diameter of entire crystal (C) is 43 cm. Useful area, however, is only 23 cm in center when a pinhole collimator (P) is attached. Outer half of crystal is masked (M).

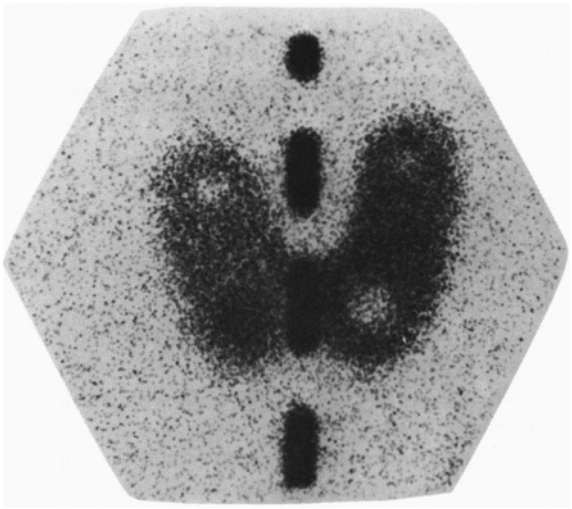

FIG. 5. Optimal pinhole view of thyroid phantom and ruler-marker imaged on 1.5 "zoom" mode. Only actual field of view is seen and extrathyroidal background is eliminated.

smaller than it appears. This is due to the design of the pinhole collimator, which masked off the peripheral half of the crystal diameter (Fig. 4). A radioiodine thyroid scan obtained in this fashion may give a false assurance that the scan covered a larger extrathyroidal area. This could result in a potentially serious misinterpretation, especially in regard to ectopic thyroid tissue. It can be avoided only if this camera's zoom mode is used with all pinhole imaging. Figure 5 was obtained with 1.5 zoom and illustrates this point. The "thyroid" is magnified and the false peripheral area eliminated. The image shows only the actual field of view in the center, as it should.

The actual field of view of the Raytheon Step 1/Step 2 pinhole system without zoom is much smaller than the resulting image leads one to believe. This is due to the structural design of the collimator, which masks off a large area of the detector. We believe this was necessary to reduce the peripheral distortion of the pinhole images using a wide field scintillation camera. Nonetheless, there may be a potentially serious problem in the interpretation of radioiodine pinhole thyroid images. Images obtained by such a system may easily have cut out a peripheral portion of a thyroid. An extrathyroidal neck mass or possibly a functioning thyroid cancer metastasis may be considered absent when, in fact, it is present under the masked portion of the detector.

To eliminate the false peripheral area one should always use 1.5 zoom for all pinhole imaging with the Raytheon system. To include sublingual, submandibular, or substernal areas, the pinhole must be moved farther away from the patient, still in zoom mode, or a suitable parallel hole collimator should be used instead.

We would like to point out that any wide field of view scintillation camera with a collimator of similar design may have the same problem.